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The Reliable Replacement Warhead Program: Background and Current Developments

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The Reliable Replacement Warhead Program: Background and Current Developments

Summary

Most current U.S. nuclear warheads were built in the 1970s and 1980s and are being retained longer than was planned. Yet they deteriorate and must be maintained. To correct problems, a Life Extension Program (LEP), part of a larger Stockpile Stewardship Program (SSP), replaces components. Modifying some components would require a nuclear test, but the United States has observed a test moratorium since 1992 so LEP rebuilds these components as closely as possible to original specifications. With this approach, the Secretaries of Defense and Energy have certified stockpile safety and reliability for the past 11 years without nuclear testing.

In the FY2005 Consolidated Appropriations Act, Congress provided $9 million to initiate the Reliable Replacement Warhead (RRW) program. The program trades key Cold War features such as high yield and low weight to gain features more valuable now, such as lower cost, greater ease of manufacture, and a further increase in use control. It plans to make these improvements by designing replacement warheads that would not add military capability. The National Nuclear Security Administration (NNSA), which operates the U.S. nuclear weapons program, views RRW as part of a comprehensive plan that would also modernize the nuclear weapons complex (the Complex), avoid nuclear testing, and reduce non-deployed weapons. The Nuclear Weapons Council, a joint NNSA-Department of Defense organization that coordinates nuclear weapons matters, conducted a competition for an RRW design, with the winning design selected in March 2007. The FY2006 RRW appropriation was $24.8 million; the FY2007 operating plan contains $35.8 million; and the FY2008 request is $88.8 million for NNSA and $30.0 million for the Navy. The House Armed Services Committee's mark would reduce the $88.8 million by $20 million and the $30.0 million by $25.0 million.

NNSA argues that it will become harder to certify current warheads with LEP because small changes may undermine confidence in warheads, perhaps leading to nuclear testing, while RRW will lead to new-design replacement warheads that will be easier to manufacture and certify without testing. Critics believe LEP and SSP can maintain the stockpile indefinitely. They worry that untested RRWs may make a return to testing more likely. They question cost savings; even if RRW could lower operations and maintenance cost, its investment cost would be high. They note that there are no military requirements for new weapons. Still others feel that neither LEP nor RRW can provide high confidence over the long term, and would resume testing. Congress and the Administration prefer to avoid a return to testing.

Issues facing the 110th Congress include how best to maintain the nuclear stockpile, whether to continue RRW or cancel it in favor of LEP, how to move RRW to engineering development if that is to be done, and how RRW might link to the Comprehensive Test Ban Treaty and nuclear nonproliferation.

This report provides background and tracks legislation. It will be updated often. CRS Report RL33748, *Nuclear Warheads: The Reliable Replacement Warhead Program and the Life Extension Program*, compares these two programs in detail.

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Background

Issue Definition

Nuclear warheads must be maintained so the United States and its friends, allies, and adversaries will be confident about the safety and effectiveness of U.S. nuclear forces. Yet warheads deteriorate with age. The current Life Extension Program (LEP) maintains them by replacing deteriorated components. The National Nuclear Security Administration (NNSA), the Department of Energy (DOE) agency in charge of the nuclear weapons program, however, expresses concerns that LEP might be unable to maintain warheads for the long term on grounds that the accumulation of minor but inevitable variations between certain original and replacement components may reduce confidence that life-extended warheads remain safe and effective. It recommends a new approach, the Reliable Replacement Warhead (RRW), described below. On the other hand, a study released in November 2006 estimates that pits, a key warhead component (see **Appendix**), should have a service life of 85 to 100 years or more,[1] which some argue makes it unnecessary to replace current warheads for decades by extending the time for which confidence in them should remain high.

Reflecting NNSA's concern, Congress first funded the Reliable Replacement Warhead (RRW) program in the FY2005 Consolidated Appropriations Act, P.L. 108-447. The entire description of RRW in the conference report was a "program to improve the reliability, longevity, and certifiability of existing weapons and their components."[2] No committee report earlier in the FY2005 budget cycle had mentioned RRW. Congress authorized the program in the FY2006 National Defense Authorization Act, P.L. 109-163, Section 3111. An issue facing Congress is how best to maintain the nuclear stockpile and the nuclear weapons complex ("the Complex") for whatever term is desired. Through a decision on this issue, Congress may affect the capabilities of U.S. nuclear forces.

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[1] R.J. Hemley et al., Pit Lifetime, JSR-06-335, MITRE Corp., November 20, 2006, available at [http://www.nukewatch.org/facts/nwd/JASON_ReportPuAging.pdf].

[2] U.S. Congress, Committee of Conference, *Making Appropriations for Foreign Operations, Export Financing, and Related Programs for the Fiscal Year Ending September 30, 2005, and For Other Purposes*, report to accompany H.R. 4818, 108th Cong., 2nd sess., 2004, H.Rept. 108-792, reprinted in U.S. Congress, *Congressional Record*, November 19, 2004, Book II, p. H10556.

Congress has spelled out dozens of goals for the RRW program. A key goal is to increase confidence, without nuclear testing, that warheads will perform as intended over the long term. Other goals are to increase ease of manufacture and certification, reduce life cycle cost, increase weapon safety and use control, and reduce environmental burden. CRS Report RL33748, *Nuclear Warheads: The Reliable Replacement Warhead Program and the Life Extension Program,* details 20 such goals. To achieve them, RRW would trade characteristics important during the Cold War for those of current importance, as described below. The Department of Defense (DOD) has approved this tradeoff. It would be impossible to meet all the goals simultaneously by modifying existing warheads, in part because their designs are so "tight" that NNSA is concerned that even minor changes might reduce confidence in the reliability of these warheads over the long term. As such, the RRW program would design new warheads to replace existing ones. In contrast, LEP makes changes chiefly to maintain weapons, and in particular minimizes changes to the nuclear explosive package (see **Appendix**).

RRW is sharply debated. Supporters anticipate that RRW will permit replacing a large stockpile of nondeployed nuclear warheads with fewer warheads in which DOD can have greater confidence over the long term, and restructuring the Complex to be smaller, safer, more efficient, and less costly. A Defense Science Board task force finds that LEP "is clearly not a sustainable approach" and recommended proceeding with RRW.[3] NNSA argued that RRWs "will be re-designed for long-term confidence in reliability and greater security, and ease of production and maintenance.[4] Critics question whether some of the tradeoffs and goals are feasible, necessary, or worth potential costs and risks. For example, one commenter argued, "The plutonium research results [see footnote 1] obliterate the chief rationale for NNSA's emerging strategy" of RRW,[5] while the *New York Times* opined that RRW "is a public-relations disaster in the making overseas" and "a make-work program championed by the weapons laboratories and belatedly by the Pentagon."[6]

Several external reviews of the program have been released or are forthcoming. The House Appropriations Committee directed NNSA to have the JASONs, a group of scientists who advise the government on defense matters, conduct an independent peer review

> to evaluate the competing RRW designs. The JASONs should evaluate the RRW design recommended by the POG [the RRW Project Officers Group] against the requirements defined by congressional legislative actions to date and the elements defined in the Department of Defense's military characteristics for a reliable replacement warhead requirements document. The JASON review

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[3] U.S. Department of Defense. Defense Science Board. *Report of the Defense Science Board Task Force on Nuclear Capabilities: Report Summary,* December 2006, p. 39, 41.

[4] U.S. Department of Energy. National Nuclear Security Administration. Office of Defense Programs. *Complex 2030: An Infrastructure Planning Scenario for a Nuclear Weapons Complex Able to Meet the Threats of the 21st Century,* DOE/NA-0013, October 2006, p. 1.

[5] Daryl Kimball, "New Reasons to Reject New Warheads," *Arms Control Today,* January/February 2007.

[6] "Busywork for Nuclear Scientists," *New York Times,* January 15, 2007, p. 18.

> should also include an analysis on the feasibility of the fundamental premise of the RRW initiative that a new nuclear warhead can be designed and produced and certified for use and deployed as an operationally-deployed nuclear weapon without undergoing an underground nuclear explosion test.[7]

The report was due March 31, 2007.[8] The schedule for this report as decided by the JASONs, NNSA, and the House Appropriations Committee calls for a preliminary report to be submitted to NNSA by March 1, 2007, an executive summary of the final report by August 1, 2007, and the final report by October 1, 2007.[9] The preliminary report, which is classified, was submitted in late January.[10] The Nuclear Weapons Complex Assessment Committee of the American Association for the Advancement of Science studied whether RRW is the best path for addressing certain potential risks of SSP and LEP and for developing a responsive infrastructure in a report released April 24, 2007.[11] A third report, mandated by the FY2006 National Defense Authorization Act, P.L. 109-163, Section 3111, is to discuss RRW's "feasibility and implementation." It was due March 1, 2007. It will "discuss the relationship of the Reliable Replacement Warhead program within the Stockpile Stewardship Program (SSP) and its impact on the current Stockpile Life Extension Programs." As of April 30, the report had not been submitted to Congress.

This report (1) describes the LEP, difficulties ascribed to it by its critics, and their responses; (2) shows how changed post-Cold War constraints might open opportunities to improve long-term warhead maintenance and reach other goals; (3) describes RRW and its pros and cons; (5) tracks RRW program developments and congressional action on budget requests; and (6) presents options and issues for Congress. An **Appendix** describes nuclear weapons, the SSP, and the Complex.

The Need to Maintain Nuclear Warheads for the Long Term

Nuclear warheads must be maintained because they contain thousands of parts that deteriorate at different rates. Some parts and materials have well-known limits on service life,[12] while the service life of other parts may be unknown or revealed

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[7] U.S. Congress. House. Committee on Appropriations. *Energy and Water Development Appropriations Bill, 2007,* H.Rept. 109-474 to accompany H.R. 5427, 109th Cong., 2nd sess., 2006, p. 110.

[8] Ibid.

[9] Information provided by Roy Schwitters, S.W. Richardson Foundation Regental Professor of Physics, University of Texas at Austin, and Chair of the JASON Steering Committee, email, January 29, 2007.

[10] Information provided by Professor Roy Schwitters, email, March 27, 2007.

[11] American Association for the Advancement of Science. Center for Science, Technology and Security Policy. Nuclear Weapons Complex Assessment Committee. C. Bruce Tarter, Chair. "The United States Nuclear Weapons Program: The Role of the Reliable Replacement Warhead." April 2007, 34 p. Available at [http://cstsp.aaas.org/files/AAAS%20RRW%20Report.pdf].

[12] U.S. General Accounting Office, *Nuclear Weapons: Capabilities of DOE's Limited Life*

(continued...)

only by multiple inspections of a warhead type over time. A 1983 report argued that maintenance requires nuclear testing:

> Certain chemically reactive materials are inherently required in nuclear weapons, such as uranium or plutonium, high explosives, and plastics. The fissile materials, both plutonium and uranium, are subject to corrosion. Plastic-bonded high explosives and other plastics tend to decompose over extended periods of time. ... portions of materials can dissociate into simpler substances. Vapors given off by one material can migrate to another region of the weapon and react chemically there. ... Materials in the warhead electrical systems ... can produce effluents that can migrate to regions in the nuclear explosive portion of the weapon. ... The characteristics of high explosives can change with time. ... Vital electrical components can change in character ...[13]

A 1987 report, written to rebut the contention of the foregoing report that nuclear testing is needed to maintain warheads, agreed that aging affects components:

> It should also be noted that nuclear weapons engineering has benefitted from a quarter century of experience in dealing with corrosion, deterioration, and creep since the time that the W45, W47, and W52 [warheads] entered the stockpile in the early sixties (just after the test moratorium of 1958-1961). ... Most of the reliability problems in the past have resulted from either an incomplete testing program during the development phase of a weapon or the aging and deterioration of weapon components during deployment.[14]

Some feel that deterioration, while a potential problem, has been overstated. A scientific panel writing in 1999 stated,

> there is no such thing as a "design life." The designers were not asked or permitted to design a nuclear weapon that would go bad after 20 years. They did their best on a combination of performance and endurance, and after experience with the weapon in storage there is certainly no reason to expect all of the nuclear weapons of a given type to become unusable after 20 or 25 years. In fact, one of the main goals of SBSS [Science-Based Stockpile Stewardship, an earlier term for the Stockpile Stewardship Program, discussed below] is to predict the life of the components so that remanufacture may be scheduled, and results to date indicate a margin of surety extending for decades. ... Until now, clear evidence of warhead deterioration has not been seen in the enduring stockpile,

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[12] (...continued)
Component Program to Meet Operational Needs, GAO/RCED-97-52, March 5, 1997, available at [http://www.globalsecurity.org/wmd/library/report/gao/rced97052.htm].

[13] "Some Little-Publicized Difficulties with a Nuclear Freeze," prepared by Dr. J.W. Rosengren, R&D Associates, under Contract to the Office of International Security Affairs, U.S. Department of Energy, October 1983, p. 5-6; reprinted in U.S. Congress. Senate. Committee on Foreign Relations. *Nuclear Testing Issues*. 99th Cong., 2nd sess., Senate Hearing 99-937, 1986, pp. 167-168.

[14] Ray Kidder, *Stockpile Reliability and Nuclear Test Bans: Response to J.W. Rosengren's Defense of His 1983 Report*, Lawrence Livermore National Laboratory, UCID-20990, February 1987, pp. 4-5.

> but the plans for remanufacture still assume that deterioration is inevitable on the timescale of the old, arbitrarily defined "design lives."[15]

The deterioration noted above pertained to warheads designed in the 1950s and early 1960s that are no longer deployed. Newer warheads correct some of these problems. As knowledge of warhead performance, materials, and deterioration increases, the labs can correct some problems and forestall others. Still other aging problems have turned out to occur more slowly than was feared. In particular, it was long recognized that plutonium would deteriorate as it aged, but it was not known how long it would take for deterioration to impair performance of the pit, the fissile core of a nuclear weapon's primary stage (see Appendix). NNSA had estimated that that would take at least 45 to 60 years, but a November 2006 study found

> there is no degradation in performance of primaries of stockpile systems [i.e., warheads] due to plutonium aging that would be cause for near-term concern regarding their safety and reliability. Most primary types have credible minimum lifetimes in excess of 100 years as regards aging of plutonium; those with assessed minimum lifetimes of 100 years or less have clear mitigation paths that are proposed and/or being implemented.[16]

During the Cold War, any deterioration problems were limited in their duration because this nation introduced generations of long-range nuclear-armed bombers and ballistic missiles, each of which would typically carry a new warhead tailored to its mission. New warheads were usually introduced long before the warheads they replaced reached the end of their service lives. Three trends concerning deterioration have emerged since the end of the Cold War: (1) SSP and other tools, described below, have greatly increased NNSA's understanding of warhead deterioration and how to deal with or prevent it. (2) By maintaining the current set of warhead designs for many years, design and production errors have been subjected to systematic identification and elimination. (3) Nuclear warheads have much more time to age, as warheads that were expected to remain in the stockpile for at most 20 years are now being retained indefinitely. The net of these trends is that understanding of deterioration, while improving, is not perfect, so deterioration remains a concern.

Current warheads were designed to meet an exacting set of constraints, such as safety parameters, yield, and conditions (such as temperature) that they would encounter in their lifetimes. Design compromises were made to meet these constraints. Ambassador Linton Brooks, NNSA Administrator, said that to meet requirements, "we designed these systems very close to performance cliffs."[17] That is, designs approached points at which warheads would fail.[18] Many parts were hard

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[15] Sidney Drell, Raymond Jeanloz, et al., *Remanufacture*, MITRE Corporation, JASON Program Office, JSR-99-300, October 1999, pp. 4, 8.

[16] R.J. Hemley et al., *Pit Lifetime,* JSR-06-335, MITRE Corp., November 20, 2006, p. 1, available at [http://www.nukewatch.org/facts/nwd/JASON_ReportPuAging.pdf].

[17] U.S. Congress, Senate Committee on Armed Services, Subcommittee on Strategic Forces, *Strategic Forces/Nuclear Weapons Fiscal Year 2006 Budget*, hearing, April 4, 2005.

[18] For example, if designers calculated that a certain amount of plutonium was the minimum (continued...)

to produce or used hazardous materials. Warheads were often hard to assemble. This approach increased the difficulty of replicating some components and of maintaining warheads. Ambassador Brooks said, "it is becoming more difficult and costly to certify warhead remanufacture. The evolution away from tested designs resulting from the inevitable accumulations of small changes over the extended lifetimes of these systems means that we can count on increasing uncertainty in the long-term certification of warheads in the stockpile."[19]

At issue is whether warheads can be maintained despite the absence of nuclear testing by replacing deteriorated components with newly-made ones built as close as possible to the original specifications. This debate has been going on for decades. In a 1978 letter to President Carter, three weapons scientists argued that the United States could go to great lengths in remanufacturing weapon components:

> it is sometimes claimed that remanufacture may become impossible because of increasingly severe restrictions by EPA or OSHA to protect the environment of the worker. ... if the worker's environment acceptable until now for the use of asbestos, spray adhesives, or beryllium should be forbidden by OSHA regulations, those few workers needed to continue operations with such material could wear plastic-film suits ... It would be wise also to stockpile in appropriate storage facilities certain commercial materials used in weapons manufacture which might in the future disappear from the commercial scene.[20]

However, in a 1987 report, three scientists at Lawrence Livermore National Laboratory stated:

- *Exact replication, especially of older systems, is impossible.* Material batches are never quite the same, some materials become unavailable, and equivalent materials are never exactly equivalent. "Improved" parts often have new, unexpected failure modes. Vendors go out of business ...
- *Documentation has never been sufficiently exact to ensure replication. ...* We have never known enough about every detail to specify everything that may be important. ...
- *The most important aspect of any product certification is testing; it provides the data for valid certification.*[21]

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[18] (...continued)
at which the warhead would work, they might add only a small extra amount as a margin of assurance.

[19] Brooks statement to Senate Armed Services Committee, April 4, 2005, p. 3.

[20] Letter from Norris Bradbury, J. Carson Mark, and Richard Garwin to President Jimmy Carter, August 15, 1978, reprinted in U.S. Congress, House Committee on Foreign Affairs and Its Subcommittee on Arms Control, International Security and Science, *Proposals to Ban Nuclear Testing,* H.J.Res. 3, 99th Cong., 1st Sess., hearings, (Washington: GPO, 1985), p. 215.

[21] George Miller, Paul Brown, and Carol Alonso, *Report to Congress on Stockpile Reliability, Weapon Remanufacture, and the Role of Nuclear Testing,* Lawrence Livermore
(continued...)

The Solution So Far: The Life Extension Program

With the end of the Cold War, the Complex, like the rest of the defense establishment, faced turmoil. Budgets and personnel were reduced, design of new weapons ended, and a test moratorium began. For a time, the chief concern of DOE's nuclear weapons management was survival of the Complex.

To address this concern and set a course for the nuclear weapons enterprise, Congress, in the FY1994 National Defense Authorization Act (P.L. 103-160), Section 3138, directed the Secretary of Energy to "establish a stewardship program to ensure the preservation of the core intellectual and technical competencies of the United States in nuclear weapons, including weapons design, system integration, manufacturing, security, use control, reliability assessment, and certification." Since then, the Clinton and Bush Administrations have requested, and Congress has approved, tens of billions of dollars for this Stockpile Stewardship Program (SSP), which is presented in NNSA's budget as "Weapons Activities."[22]

SSP uses data from past nuclear tests, small-scale laboratory experiments, large-scale experimental facilities, examination of warheads, and the like to better understand nuclear weapon science. It uses this knowledge to improve computer codes that simulate aspects of weapons performance to aid the nuclear weapons laboratories' understanding of it. Such advances help scientists analyze data from past nuclear tests more thoroughly, mining it to extract still more information. Theory, simulation, and data reinforce each other: theory refines simulation, simulation helps check theory, theory and simulation guide researchers to look for certain types of data, and data help check simulation and theory.

A key task of the Complex is to monitor warheads for signs of actual or future deterioration. This work is done through a program that conducts routine surveillance of warheads in the stockpile by closely examining 11 warheads of each type per year to search for corrosion, gases, and other evidence of deterioration. Of the 11, one is taken apart for destructive evaluation, while the other 10 are evaluated nondestructively and returned to the stockpile.[23] In addition, an Enhanced Surveillance Program supports surveillance; its goal "is to develop diagnostic tools and predictive models that will make it possible to analyze and predict the effects that aging may have on weapon materials, components, and systems."[24]

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[21] (...continued)
National Laboratory, UCRL-53822, October 1987, p. 25. For an opposing view, see R.E. Kidder, *Maintaining the U.S. Stockpile of Nuclear Weapons During a Low-Threshold or Comprehensive Test Ban*, Lawrence Livermore National Laboratory, UCRL-53820, October 1987, esp. pp. 6-9.

[22] See CRS Report RL32852, *Energy and Water Development: FY2006 Appropriations*, coordinated by Carl Behrens, section on Nuclear Weapons Stockpile Stewardship.

[23] Information provided by NNSA, May 9, 2005.

[24] Katie Walter, "Enhanced Surveillance of Aging Weapons," *Science & Technology*
(continued...)

When routine surveillance detects warhead problems, the Complex applies knowledge gained through SSP to fix problems through the Life Extension Program (LEP), which attempts "to extend the stockpile lifetime of a warhead or warhead components at least 20 years with a goal of 30 years"[25] beyond the originally-anticipated service life.

A warhead's components may be divided into two categories: those that are part of the nuclear explosive package (NEP), and those that are not. As described in the **Appendix**, the NEP is the part of the warhead that explodes, as distinct from the more numerous components like the outer case or arming system. Because non-NEP components can be subjected to extensive experiments and nonnuclear laboratory tests, they can be modified as needed under LEP to incorporate more advanced electronics or safer materials. In contrast, NEP components cannot be subjected to nuclear tests because the United States has observed a moratorium on nuclear testing since 1992. As a result, LEP seeks to replicate these components using original designs and, insofar as possible, original materials. In this way, it is hoped, components will be close to the originals so that they can be qualified for use in warheads. Because NEP components cannot be tested while other components can be, long-term concern focuses on the former.

Warheads contain several thousand components. While not all need to be refurbished in an LEP, some are difficult to fabricate, and assembly may be difficult, as discussed earlier. As a result, the LEP for an individual warhead type is a major campaign requiring extensive preparatory analysis and detailed work on many components that can take many years. For example, NNSA describes the LEP for the W76 warhead for Trident submarine-launched ballistic missiles as follows:

> The W76 LEP will extend the life of the W76 for an additional 30 years with the FPU [first production unit] in FY 2007. Activities include design, qualification, certification, production plant Process Prove-In (PPI), and Pilot Production. The pre-production activities will ensure the design of refurbished warheads meets all required military characteristics. Additional activities include work associated with the manufacturability of the components including the nuclear explosive package; the Arming, Firing, and Fuzing (AF&F) system; gas transfer system; and associated cables, elastomers, valves, pads, cushions, foam supports, telemetries, and miscellaneous parts.[26]

Stockpile stewardship has made great strides in understanding weapons science, in predicting how weapons will age, and in predicting how they will fail. Most observers agree with the following assessment by Ambassador Brooks in congressional testimony of April 2005:

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[24] (...continued)
Review, January/February 1998, p. 21.

[25] U.S. Department of Energy. Office of Chief Financial Officer. *FY2007 Congressional Budget Request*, COE/CF-002, February 2006, vol. I, p. 79. Also, see ibid., pp. 79-80, for a weapon-by-weapon description of LEP activities planned for FY2007.

[26] Department of Energy, *FY2007 Congressional Budget Request*, vol. 1, p. 79.

> today *stockpile stewardship is working*, we are confident that the stockpile is safe and reliable, and there is no requirement at this time for nuclear tests. Indeed, just last month, the Secretary of Energy and Secretary of Defense reaffirmed this judgment in reporting to the President their ninth annual assessment of the safety and reliability of the U.S. nuclear weapons stockpile. ... Our assessment derives from ten years of experience with science-based stockpile stewardship, from extensive surveillance, from the use of both experiments and computation, and from professional judgment.[27] [original emphasis]

Is LEP Satisfactory for the Long Term?

In the turmoil following the end of the Cold War, it is scarcely surprising that the method chosen to maintain the stockpile — a task that had to be performed in the face of the many changes affecting the Complex and the many unknowns about its future — was to minimize changes. Now, with SSP well established, NNSA feels that it is appropriate to use a different approach to warhead maintenance, one that builds on the success of SSP and challenges the notion underlying LEP that changes must be held to a minimum.

Advocates of RRW recognize that LEP has worked well and concede that it can probably maintain warheads over the short term. Their concern is with maintaining reliability of warheads over the long term. They assert that LEP is not suited to the task because it will become harder to make it work as the technology under which current warheads were created becomes increasingly archaic and as materials, equipment, processes, and skills become unavailable. They maintain that if the labs were to lose confidence that they could replicate NEP components to near-original designs using near-original materials and processes, the United States could ultimately face a choice between resuming nuclear tests or accepting reduced confidence in reliability. Instead, for example, the three nuclear weapons laboratories (Los Alamos, Livermore, and Sandia) argue that a "vision of sustainable warheads with a sustainable [nuclear] enterprise can best be achieved by shifting from a program of warhead refurbishment to one of warhead replacement."[28]

Advocates of RRW note further that while the current stockpile — most units of which were manufactured between 1979 and 1989 — was designed to deter and, if necessary, defeat the Soviet Union, the threat, strategy and missions have changed, leaving the United States with the wrong stockpile for current circumstances. Ambassador Brooks said that current warheads are wrong technically because "we would [now] manage technical risk differently, for example, by 'trading' [warhead] size and weight for increased performance margins, system longevity, and ease of manufacture." These warheads were not "designed for longevity" or to minimize cost, and may be wrong militarily because yields are too high and "do not lend themselves to reduced collateral damage." They also lack capabilities against buried targets or biological and chemical munitions, and they do not take full advantage of

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[27] Brooks statement to Senate Armed Services Committee, April 4, 2005, p. 2.

[28] K. Henry O'Brien et al., *Sustaining the Nuclear Enterprise — A New Approach*, published jointly by Lawrence Livermore, Los Alamos, and Sandia National Laboratories, UCRL-AR-212442, May 20, 2005, p. 3.

precision guidance.[29] Furthermore, LEP's critics believe the stockpile is wrong politically because it is too large:

> We retain "hedge" warheads in large part due to the inability of either today's nuclear infrastructure, or the infrastructure we expect to have when the stockpile reductions are fully implemented in 2012, to manufacture, in a timely way, warheads for replacement or for force augmentation, or to act to correct unexpected technical problems.[30]

Finally, they believe the stockpile is wrong in terms of physical security because it was not designed for a scenario in which terrorists seize control of a nuclear weapon and try to detonate it in place. According to Brooks, "If we were designing the stockpile today, we would apply new technologies and approaches to warhead-level use control as a means to reduce physical security costs."[31]

Advocates of LEP challenge each assertion. They believe that LEP can continue to maintain warheads. They note that criticisms of LEP are vague: not that LEPs will fail, but that life-extended warheads might at some future point lead to a reduction in confidence. LEP supporters do not accept even that criticism. As Richard Garwin, IBM Fellow emeritus said,

> I don't agree with the generally stated assumption that confidence and the reliability of our existing nuclear weapons will inevitably decline with time as the weapons age. ... the Science-Based Stockpile Stewardship Program and, in particular, the advanced scientific computing capabilities that have been procured at great cost over the last 15 years for the Stockpile Stewardship Program, have paid off handsomely, as indicated in confidence in increased pit longevity. Thus, in the case of the essential and sensitive thermonuclear weapon primaries, the passage of time has brought greater, not lesser, confidence in pit longevity. ... And with the passage of time and the improvement in computing tools, I believe that confidence in the reliability of the existing legacy weapons will increase rather than diminish, just as has been the case with the nuclear weapon pits.[32]

They challenge the assertion that RRW would improve the current stockpile. In this view, new weapons may not offer much new capability: earth penetrators could not destroy hardened facilities buried very deeply or at imprecisely-known locations, and nuclear weapons are of questionable effectiveness against chemical and biological agents.[33] They note that Congress rejected funds for the Robust

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[29] Ibid., pp. 2-3.

[30] Ibid., p. 3.

[31] Ibid., p. 4.

[32] U.S. Congress. House. Committee on Appropriations. Subcommittee on Energy and Water Development. Hearing on nuclear weapon activities. 109th Congress, 1st Session, March 29, 2007.

[33] Roger Speed and Michael May, "Assessing the United States' Nuclear Posture," in George Bunn and Christopher Chyba, eds., *U.S. Nuclear Weapons Policy: Confronting Today's Threats,* Center for International Security and Cooperation, Stanford University, (continued...)

Nuclear Earth Penetrator, which many Members perceived as being a new nuclear weapon, and that the FY2006 National Defense Authorization Act, P.L. 109-163, Section 3111, set "fulfill[ing] current mission requirements of the existing stockpile" as an objective for the RRW program. They anticipate that RRWs, like any other product, would have "birth defects," whereas such defects have been wrung out of existing warheads, and believe that such defects could require a larger stockpile. They state that performance margins of current warheads are adequate and can be improved somewhat if needed, such as by new systems to deliver boost gas. They question the argument that RRW would reduce physical security costs on grounds that a terrorist attempt to seize and detonate a nuclear warhead in place is most unlikely given the high level of security currently in place, and doubt that Congress or NNSA would reduce the guard force because of RRW.

RRW and the Transformation of Nuclear Warheads

The nuclear stockpile was designed to meet Cold War requirements. For example, high explosive yield per unit of warhead weight (the "yield-to-weight ratio") was critically important while cost, ease of manufacture, and reduction of hazardous material were less so. Now, yield-to-weight has become less important, the others just mentioned have become more important, new constraints have appeared in the wake of 9/11, and warheads must continue to be safe and reliable. As a result, RRW advocates claim, it is possible and necessary to transform the stockpile to reflect these changes.

With RRW, NNSA and DOD are revisiting tradeoffs underlying the current stockpile in order to adapt to post-Cold War changes and meet possible future requirements. NNSA and DOD assert RRW would trade negligible sacrifices to secure major gains. This section presents some Cold War warhead requirements, how they have changed, and implications of these changes for RRW and LEP.

Yield-to-weight ratio. A major characteristic of warheads for ballistic missiles was a high yield-to-weight ratio.[34] Lower weight let each missile carry more warheads to more distant targets; higher yield made each warhead better able to destroy its target; and high yield-to-weight enabled these goals to be met at the same time. For example, the W88 warhead for the Trident II (D5) submarine-launched ballistic missile uses a conventional high explosive (CHE) that is more sensitive to impact than insensitive high explosive (IHE) used on many other warhead types. IHE is safer to handle, but CHE packed more energy per unit weight. A missile could carry the lighter CHE warheads to a greater distance, so a submarine could stand off farther from its targets. Increased ocean patrol area forced the Soviet Union to spread out its antisubmarine assets, improving submarine survivability. Hard-to-manufacture designs, hazardous materials, and other undesirable features were deemed acceptable tradeoffs to maximize yield-to-weight.

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[33] (...continued)
and Brookings Institution Press, Washington, 2006, pp. 256-264.

[34] Bombs were less constrained in weight because bombers carry heavier loads than missiles.

Now, ballistic missiles carry fewer warheads than they did during the Cold War, so each warhead can be heavier.[35] In particular, the first RRW, “RRW-1,” which is to replace some W76 warheads now on the Trident II submarine-launched ballistic missile, will have the yield of the W76 but the higher weight of the W88, resulting in less yield per unit weight. The added weight is allocated to design features to improve use control, margin (excess performance designed into a warhead beyond the minimum required for it to perform as intended), ease of production, and the like.

LEP advocates see current warheads as satisfactory. Barry Hannah, chairman of the RRW POG, said, “The W76 LEP that is currently underway is an excellent program in terms of technology, schedule, and cost. I believe it meets the Navy's needs.”[36] They point to risks in RRW, such as defects in design or manufacturing, that are typical of most new products.

Nuclear Testing. Between 1945 and 1992, the United States conducted over 1,000 nuclear tests, mostly for weapons design.[37] These tests added confidence that a weapon incorporating hard-to-manufacture components was made correctly, that a weapon would work at the extremes of temperatures to which it might be exposed, and that the design was satisfactory in other ways. Testing also enabled the labs to validate changes to existing warhead designs. With a congressionally-imposed U.S. nuclear test moratorium that began in October 1992[38] and has since been extended, the United States can no longer rely on tests to validate designs. Instead, RRW-1 seeks to provide high confidence in the design without nuclear testing by being a “close neighbor” of previously-tested designs, staying within design parameters that past nuclear tests have validated, and building in high margins. RRW advocates express concern that current warheads were designed with “thin” margins, and that minor changes as a result of LEPs can erode these margins further, possibly reducing confidence in these warheads that could testing to restore.

Advocates of LEP have high confidence in current warheads, and believe that this confidence is growing despite the absence of testing, as noted earlier. The JASON study on pit aging, in this view, delays by decades the time when pits would have to be manufactured for current warheads, thus delaying a potentially large risk

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[35] Ballistic missiles carry warheads inside reentry vehicles (RVs). An RV is a streamlined shell that protects its warhead from the intense heat and other stresses of reentering the atmosphere at high speed. RVs are designed to carry a specific type of warhead on a specific missile; the maximum stress that the RV encounters is carefully studied. Increasing warhead weight significantly would increase these stresses, possibly causing the RV to fail and the warhead to burn up, fail, or miss its target by a wide margin.

[36] Information provided by Dr. Barry Hannah, SES, Branch Head, Reentry Systems, Strategic Systems Program, U.S. Navy, telephone conversation with the author, October 23, 2006.

[37] The United States conducted 1,030 tests, of which 883 were weapons related. (The United Kingdom conducted another 24 tests at the Nevada Test Site.) U.S. Department of Energy, Nevada Operations Office, Office of External Affairs, *United States Nuclear Tests, July 1945 through September 1992*, DOE/NV-209, rev. 14, December 1994, p. viii.

[38] The moratorium was begun pursuant to Section 507 of P.L. 102-377, FY1993 Energy and Water Development Appropriations Act, signed into law October 2, 1992.

factor that could lead to testing. In contrast, RRW missile warheads, such as RRW-1, would require the manufacture of new pits, and any new product runs the risk of design or manufacturing defects, which in this case could lead to testing.

Others hold that neither RRW nor LEP provides confidence in the stockpile. In this view, RRW uses untested designs, while the many changes introduced by LEPs move current warheads away from tested designs, so the only way to restore confidence is to resume a nuclear test program that would meet current needs with a much lower rate and yield of testing than during the Cold War.

Performance, Schedule, and Cost Tradeoffs. Performance has always been the dominant consideration for nuclear weapons. Weapons must meet standards for safety and reliability, and meet other military characteristics. During the Cold War, schedule was also critical. With new missiles and nuclear-capable aircraft entering the force at a sustained pace, warheads and bombs had to be ready on a schedule dictated by their delivery systems. As a result, "our nuclear warheads were not designed ... to minimize DOE and DOD costs."[39] Now, reducing cost has a higher priority. Cost reduction is also more feasible: performance is still dominant, but no imminent external threat drives the schedule.

RRW-1 offers many features that, its backers claim, will reduce costs over its life cycle. It will be designed for ease of manufacture and reduce use of hazardous material, lowering manufacturing cost. Enhanced use-control and use-denial features may slow the growth of physical security costs. Reduced use of hazardous materials and a design that permits easier disassembly will lower dismantlement cost. RRW's proponents also raise concerns that it is becoming more costly to maintain existing warheads; for example, plants to make certain materials used in current warheads but that are no longer commercially available may cost millions of dollars to build.

LEP supporters state that delaying pit manufacture for decades by continuing to use existing pits in current warheads will save many billions of dollars. They note that RRW is linked to a major upgrade of the nuclear weapons complex, which would be costly, and that the RRW program may involve manufacture of thousands of new warheads and dismantlement of thousands of old ones, adding costs. A study by the American Association for the Advancement of Science found, "an RRW program would likely add to costs in the near term, and it is not yet possible to determine when (and whether) the RRW could lead to savings in the long term."[40]

Environment, Safety, and Health (ES&H). During the Cold War, the urgency of production and limited knowledge of the ES&H effects of materials used or created in the nuclear weapons enterprise led to the use of hazardous materials, dumping contaminants onto the ground or into rivers, exposing citizens to radioactive fallout from nuclear tests, and the like. Now, ES&H concerns have grown within the

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[39] Brooks statement to Senate Armed Services Committee, April 4, 2005, p. 3.

[40] American Association for the Advancement of Science. Nuclear Weapons Complex Assessment Committee. *The United States Nuclear Weapons Program: The Role of the Reliable Replacement Warhead.* April 2007, p. 25. Available at [http://cstsp.aaas.org/files/AAAS%20RRW%20Report.pdf].

Complex, reflecting their rise in civil society at large, leading to a strong interest in minimizing the use of hazardous materials in warheads and their production.

RRW advocates note that reduction of hazardous materials is a design goal of RRW. A less stringent yield-to-weight requirement permits substitution of safer materials, even if they are somewhat heavier, for some hazardous materials. Manufacturing processes are simpler, reducing hazardous waste and increasing safety. Substitution of insensitive high explosive for conventional high explosive, it is argued, would increase worker safety. LEP supporters argue that the ability to defer pit manufacture for decades improves ES&H, and that existing manufacturing processes are well understood and have incorporated proper safety precautions.

Skill Development and Transfer. During the Cold War, the design of dozens of warhead types, the conduct of over 1,000 nuclear tests, and the production of thousands of warheads exercised the full range of nuclear weapon skills. Now, with no design or testing, no new-design warheads being produced, and with warheads being refurbished at a slower pace than that at which they were originally produced, some have raised concern that Complex personnel are not adequately challenged. In this view, skill development and transfer can no longer be simply a byproduct of the work, but must be an explicit goal of the nuclear weapons program.

RRW advocates state that since RRW is a new design, designers must confront the full range of tradeoffs simultaneously, balancing yield, weight, cost, safety, ease of manufacture, use control, reduction of hazardous material, etc. In contrast, in this view, LEP constrains choices for the nuclear explosive package because replication is required to minimize divergence from parameters validated by nuclear testing. LEP supporters cite the American Association for the Advancement of Science study: "Although life extension is not equivalent to executing a new design, it nonetheless employs many of the same tools, processes, and disciplines."[41]

RRW and Nuclear Weapons Complex Transformation

Supporters see RRW as the basis for addressing Complex transformation. Representative David Hobson, Chairman of the House Energy and Water Development Appropriations Subcommittee in the 108th and 109th Congresses, was RRW's prime sponsor. In introducing the FY2005 energy and water bill (H.R. 4614) to the House, he emphasized the need to redirect the Complex:

> much of the DOE weapons complex is still sized to support a Cold War stockpile. The NNSA needs to take a 'time-out' on new initiatives until it completes a review of its weapons complex in relation to security needs, budget constraints, and [a] new stockpile plan.[42]

[41] American Association for the Advancement of Science, *The United States Nuclear Weapons Program: The Role of the Reliable Replacement Warhead*, p. 23.

[42] *Congressional Record*, June 25, 2004, p. H5085.

He saw RRW as a key part of his effort to redirect U.S. nuclear strategy, reshape the nuclear weapons stockpile and Complex to support that strategy, undertake weapons programs consistent with that strategy, and reject those inconsistent with it.[43]

Some see RRW as the key to transforming the Complex into the responsive infrastructure envisioned in the 2001 Nuclear Posture Review. Thomas D'Agostino, NNSA Deputy Administrator for Defense Programs, said,

> By "responsive" we refer to the resilience of the nuclear enterprise to unanticipated events or emerging threats, and the ability to anticipate innovations by an adversary and to counter them before our deterrent is degraded. ... much remains to be done to achieve stockpile and infrastructure transformation. ... The "enabler" for transformation is our concept for the RRW. The RRW will benefit from relaxed Cold War design constraints that maximized yield to weight ratios. This will allow us to design replacement components that are easier to manufacture; are safer and more secure; eliminate environmentally dangerous, reactive, and unstable materials ... RRW, we believe, will provide enormous leverage for a more efficient and responsive infrastructure and opportunities for a smaller stockpile.[44]

He also said, "We have worked closely with the DoD to establish goals for 'responsiveness,' that is, timelines to address stockpile problems or deal with new or emerging threats. For example, our goal is to understand and fix most problems in the stockpile within 12 months of their discovery."[45]

To meet these goals, NNSA has proposed a "Complex 2030" plan for restructuring the Complex.[46] It would consolidate fissile material, eliminate some redundancies in R&D facilities, and consolidate elements of the current Complex. It assumes Complex reconfiguration completed around 2030. As a result, even if the United States proceeds with RRW, the Complex would, for decades, need to support current warheads and RRWs simultaneously, so a Complex-in-transition would support a stockpile-in-transition. Because RRW would be designed in part for ease of manufacture, advocates claim it would permit a simpler a smaller and less costly Complex. In NNSA's view, Complex 2030, combined with easier-to-produce RRWs, would be more responsive to DOD's needs than the current Complex. Another plan, by a Secretary of Energy Advisory Board (SEAB) task force, proposed more consolidation of production, experimental equipment, and uranium and

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[43] Congressman David Hobson, "U.S. Nuclear Security in the 21st Century," address to the Arms Control Association, Washington, DC, February 3, 2005. (Transcript as delivered.)

[44] "Statement of Thomas P. D'Agostino, Deputy Administrator for Defense Programs, National Nuclear Security Administration, Before the House Armed Services Committee, Subcommittee on Strategic Forces," April 5, 2006, p. 3, 6.

[45] "Statement of Thomas P. D'Agostino ...," April 5, 2006, p. 4.

[46] U.S. Department of Energy. National Nuclear Security Administration. Office of Defense Programs. *Complex 2030: An Infrastructure Planning Scenario for a Nuclear Weapons Complex Able to Meet the Threats of the 21st Century*, DOE/NA-0013, October 2006.

plutonium than the Complex 2030 plan.[47] One of its elements was a Consolidated Nuclear Production Center (CNPC), which would produce all uranium and plutonium components for nuclear weapons, as well as assembling, surveilling, and disassembling weapons, and storing all weapons not in DOD custody.[48]

In a letter to Secretary of Energy Samuel Bodman in November 2006, Representative Hobson expressed concern that DOE decided not to analyze the SEAB plan and instead considered Complex 2030 as its proposed action.[49]

> If the Department is not willing to conduct a thorough and objective analysis of all reform alternatives including the CNPC, and instead is determined to conduct an obviously prejudicial process aimed at ensuring the Department's preferred outcome, then I will not support funding for the Complex 2030 efforts, including the Reliable Replacement Warhead (RRW) program. RRW is a deal with Congress, but the deal requires a serious effort by the Department to modernize, consolidate, and downsize the weapons complex. Absent that, there is no deal.[50]

In January 2007, NNSA stated it would evaluate the SEAB plan.[51]

Representative Peter Visclosky, Chairman of the Energy and Water Development Appropriations Subcommittee, also expressed concerns about the link between RRW and Complex transformation:

> I am also troubled by the apparent unbridled enthusiasm of the nuclear weapons complex over the Reliable Replacement Warhead and wish I saw that same enthusiasm replicated, as far as their dedication to downsizing the complex. ... The department [DOE] will have to develop a modernization plan that is near-term and demonstrates a recognition that the long-term requirements of the nuclear weapons complex are tied to a much smaller nuclear stockpile.[52]

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[47] U.S. Department of Energy. Secretary of Energy Advisory Board. Nuclear Weapons Complex Infrastructure Task Force. *Recommendations for the Nuclear Weapons Complex of the Future,* 2005.

[48] Ibid., p. 14.

[49] DOE announced this decision in "Notice of Intent to Prepare a Supplement to the Stockpile Stewardship and Management Programmatic Environmental Impact Statement — Complex 2030," in U.S. National Archives and Records Administration. Office of the Federal Register. *Federal Register,* October 19, 2006, p. 61731-61736.

[50] Letter from David L. Hobson, Chairman, Energy and Water Development Appropriations Subcommittee, to Samuel W. Bodman, Secretary of Energy, November 16, 2006.

[51] U.S. Department of Energy. National Nuclear Security Administration. Office of Defense Programs. *Report on the Plan for Transformation of the National Nuclear Security Administration Nuclear Weapons Complex,* January 31, 2007, p. iii.

[52] U.S. Congress. House. Committee on Appropriations. Subcommittee on Energy and Water Development. Hearing on DOE's FY2008 budget for NNSA programs, March 29, 2007.

RRW Program Developments

Representatives of the Office of the Secretary of Defense, the armed services, and NNSA participate in the Nuclear Weapons Council, which under 10 U.S.C. 179 coordinates their efforts in this area. The council approved forming a DOD-DOE Project Officers' Group (POG) for the RRW program in March 2005. According to NNSA, the POG is composed of representatives of NNSA, the nuclear weapon labs (Los Alamos, Lawrence Livermore, and Sandia), the Office of the Secretary of Defense, the U.S. Strategic Command, the Navy, the Air Force, and Lockheed Martin Space Systems Company.[53] There are also observers from the Office of the Chief of Naval Operations, the Defense Threat Reduction Agency, and three nuclear weapon plants (Kansas City, Pantex, and Y-12).[54] In practice, POGs do not take votes, so members and observers participate on an equal footing. The Nuclear Weapons Council tasked the POG to conduct an 18-month design competition, which started with the first POG meeting in May 2005. In the competition, two teams — Los Alamos and Sandia's New Mexico branch, and Lawrence Livermore and Sandia's California branch — were tasked to provide warhead designs consistent with RRW program objectives. The council set the terms of reference for the designs in a memorandum to the POG. DOD requested that the study be done as a competition between the two teams rather than as a collaboration, according to NNSA.

By February 2006, the two teams had become fully confident that their designs would meet military requirements, would not require nuclear testing to certify, and would meet other criteria including ease of manufacturing, reduction in the use of hazardous and exotic materials, and significantly enhanced safety and use control. The teams completed their preliminary designs in March 2006, and released their designs to the competing team. Over the next few months, the labs, POG, and NNSA reviewed and analyzed candidate design concepts. On November 30, 2006, the POG briefed the council on RRW, and the council determined that RRW "is feasible as a strategy for sustaining the nation's nuclear weapons stockpile for the long-term without underground nuclear testing." According to a December 1 press release, the council was expected to select a preferred design "in the next few weeks."[55] On March 2, NNSA announced that the Nuclear Weapons Council had selected the California team's design. According to NNSA,

> The two nuclear weapons laboratories both submitted designs that fully met all RRW requirements. However, [Acting NNSA Administrator Thomas] D'Agostino noted that higher confidence in the ability to certify the Livermore

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[53] Lockheed Martin Space Systems Company, a subsidiary of Lockheed Martin Corporation, and its predecessor organizations have developed and manufactured all U.S. SLBMs. This company is on the POG to provide expertise on compatibility of candidate SLBM replacement warhead designs with their delivery system, Trident II missiles.

[54] The Savannah River Site, another nuclear weapons plant, is not involved in the POG because it does not design warhead components; its role is to supply tritium for warheads.

[55] U.S. Department of Energy. National Nuclear Security Administration. "Nuclear Weapons Officials Agree to Pursue RRW Strategy." Press release, December 1, 2006.

> design without underground testing was the primary reason for its selection. That design was more closely tied to previous underground testing.[56]

The competing designs were for a submarine-launched ballistic missile (SLBM) replacement warhead. This was consistent with a statement in a House Armed Services Committee report: "the committee encourages the Department of Defense and the Department of Energy to focus initial Reliable Replacement Warhead efforts on replacement warheads for Submarine Launched Ballistic Missiles."[57] Specifically, the designs sought to provide the military capability of the W76 warhead. Because of this SLBM focus, the Navy is the POG chair, and the Air Force is co-chair. At the same time, the designs were made so that they can also be used on land-based intercontinental ballistic missiles. In this way, the RRW could serve as a backup in case ICBM warheads encountered a problem. This approach could permit reducing the number of warhead types, meeting an objective in the House Appropriations Committee's energy and water report: "A more reliable replacement warhead will allow long-term savings by phasing out the multiple redundant Cold War warhead designs that require maintaining multiple obsolete production technologies to maintain the older warheads."[58]

NNSA requests $88.8 million for FY2008, with most of the funds to be used for a design definition and cost study. The study is to be completed by the end of 2007.[59] The FY2007 National Defense Authorization Act (P.L. 109-364, Section 3111) sets as an objective having the first production unit (FPU, the first complete warhead from a production line certified for deployment) of RRW in 2012, and NNSA stated in April 2007 that 2012 remains its target date for FPU. However, a Nuclear Weapons Council memorandum of March 2007 states, "Given the level of maturity of the [RRW] design effort to date, our planning target for the First Production Unit, is 2014 plus or minus two years."[60] Each year, it would be up to Congress to decide whether to fund the program as requested, modify it, or cancel it.

RRW involves plants as well as labs. The plants involved in RRW (Kansas City, Pantex, and Y-12) provided the labs with design information beginning at an early stage. They are working with the labs and NNSA to identify options for manufacturing processes and infrastructure transformation, such as steering the labs away from hard-to-manufacture designs. The contribution of the plants will change

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[56] U.S. Department of Energy. National Nuclear Security Administration. "Design Selected for Reliable Replacement Warhead." Press release, March 2, 2007.

[57] U.S. Congress, House Committee on Armed Services, *National Defense Authorization Act for Fiscal Year 2006,* H.Rept. 109-89, to accompany H.R. 1815, 109th Cong., 1st sess., 2005, p. 464.

[58] U.S. Congress, House Committee on Appropriations, *Energy and Water Development Appropriations Bill, 2006,* H.Rept. 109-86, to accompany H.R. 2419, 109th Cong., 1st sess., 2005, p. 130.

[59] U.S. Department of Defense and Department of Energy. Nuclear Weapons Council. Memorandum for the Nuclear Weapons Council, "Reliable Replacement Warhead 1 (RRW-1) Path Forward," by Kenneth Krieg, Chairman, March 18, 2007.

[60] Ibid., attachment by RADM S.E, Johnson, U.S. Navy, and T. D'Agostino, NNSA.

over time as the designs become more mature, at which time designers would be in a position to accept detailed recommendations on manufacturing from the plants. The results of this work, NNSA states, will be incorporated in the design and cost study. This role of the plants is in keeping with numerous congressional statements that ease and safety of manufacture, cost savings, and reduction of hazardous materials are goals of RRW.

Congressional Action on the FY2006 RRW Request

Consistent with congressional action in FY2005, NNSA requested $9.4 million for RRW for FY2006.[61] The request stated that the program "is to demonstrate the feasibility of developing reliable replacement components that are producible and certifiable for the existing stockpile. The initial focus will be to provide cost and schedule efficient replacement pits [see **Appendix**] that can be certified without Underground Tests."[62]

The House Appropriations Committee reported the FY2006 Energy and Water Development Appropriations Bill, H.R. 2419, on May 18, 2005 (H.Rept. 109-86). The bill passed the House, 416-13, on May 24 with no amendments to the Weapons Activities section. In its report, the committee offered a "qualified endorsement" of RRW "contingent on the intent of the program being solely to meet the current military characteristics and requirements of the existing stockpile." (p. 128) (Page numbers in this section refer to H.Rept. 109-86.) It did not endorse RRW if it produces new weapons for new military missions. (p. 128)

The committee saw RRW as part of a new Sustainable Stockpile Initiative, under which DOE would "develop an integrated RRW implementation plan that challenges the [nuclear weapons] complex to produce a RRW certifiable design while implementing an accelerated warhead dismantlement program and an infrastructure reconfiguration proposal that maximizes special nuclear material [essentially, highly enriched uranium and weapons-grade plutonium] consolidation." (p. 128)

The committee focused on RRW throughout its discussion of Weapons Activities, linked RRW to many Weapons Activities programs, and used the potential of RRW as the rationale to reduce or delay several requested programs. Its many actions and statements on RRW include the following:

- "The RRW weapon will be designed for ease of manufacturing, maintenance, dismantlement, and certification without nuclear testing, allowing the NNSA to transition the weapons complex away from a large, expensive Cold War relic into a smaller, more efficient

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[61] U.S. Department of Energy, Office of Management, Budget, and Evaluation/CFO, *FY2006 Congressional Budget Request*, vol. I, National Nuclear Security Administration, DOE/ME-0046, February 2005, p. 68. (Hereafter cited as Department of Energy, *FY2006 Congressional Budget Request*, vol. I.)

[62] Department of Energy, *FY2006 Congressional Budget Request*, Vol. I, p. 82.

modern complex. A more reliable replacement warhead will allow long-term savings by phasing out the multiple redundant Cold War warhead designs that require maintaining multiple obsolete production technologies to maintain the older warheads." (p. 128)

- "The Committee directs the Secretary of Energy to establish a Federal Advisory Committee on the Reliable Replacement Warhead initiative..." (p. 128)

- A rebaselined LEP, an RRW program plan, and a dismantlement plan would provide "reliable nuclear deterrence" with a stockpile after 2025 that is significantly smaller than the stockpile level planned for 2012. As a result, "the current Life Extension Plans will be scoped back to lower levels and the resources will be redeployed to support the Sustainable Stockpile Initiative." Accordingly, the committee recommended reducing the budget request for Directed Stockpile Work, a major category of Weapons Activities that directly supports weapons in the stockpile, by $137.3 million to $1,283.7 million. (p. 129)

- The committee recommended increasing RRW funding from $9.4 million to $25.0 million "to accelerate the planning effort to initiative a competition between the NNSA weapons laboratories to develop the design for the RRW re-engineered and remanufactured warhead." (p. 130)

- The committee recommended eliminating the $4.0 million requested to study the Robust Nuclear Earth Penetrator, in part because it "threatens Congressional and public support for sustainable stockpile initiatives that will actually provide long-term security and deterrent value for the Nation." (p. 131)

- Test Readiness is a program to enable the resumption of nuclear testing at Nevada Test Site should that be deemed necessary. Last year, the committee opposed a move to reduce the test readiness posture (the time between a presidential decision to test and the conduct of the test) from 24 to 18 months, this year, it added RRW to the rationale against an 18-month posture: "The initiation of the Reliable Replacement Warhead (RRW) program designed to provide for the continuance of the existing moratorium on underground nuclear testing by insuring the long-term reliability of the nuclear weapons stockpile obviates any reason to move to a provocative 18-month test readiness posture." (p. 132) Accordingly, it recommended reducing Test Readiness funds from $25.0 million to $15.0 million.

- The committee noted that "Congressional testimony by NNSA officials is beginning to erode the confidence of the Committee that the Science-based Stockpile Stewardship is performing as advertised." Accordingly, it "redirects ASCI [Advanced Simulation and Computing] funding to maintain current life extension

production capabilities pending the initiation of the Reliable Replacement Warhead program" and recommended reducing funding from $660.8 million to $500.8 million. (pp. 133-134)

- The committee recommended eliminating the $7.7 million requested for the Modern Pit Facility (see **Appendix**). It recommended that "NNSA focus its efforts on how best to lengthen the life of the stockpile and minimize the need for an enormously expensive infrastructure facility until the long-term strategy for the physical infrastructure of the weapons complex has incorporated the Reliable Replacement Warhead strategy..." (p. 134)

- The committee recommended eliminating the $55.0 million requested for construction of the Chemistry and Metallurgy Research Facility Replacement (CMRR) at Los Alamos. "Construction at the CMRR facility should be delayed until the Department [of Energy] determines the long-term plan for developing the responsive infrastructure required to maintain the nation's existing nuclear stockpile and support replacement production anticipated for the RRW initiative." (p. 136)

The House Armed Services Committee reported the FY2006 National Defense Authorization Bill, H.R. 1815, on May 20 (H.Rept. 109-89). The bill passed the House, 390-39, on May 25 with no amendments concerning RRW. The committee recommended providing the amount requested for RRW. The report stated: "The committee firmly believes that the nation must ensure that the nuclear stockpile remains reliable, safe, and secure and that national security requires transforming the Cold War-era nuclear complex. Thus, the committee supports the Reliable Replacement Warhead program. To clearly articulate the congressional intent underlying this program authorization, the committee further states the key goals of the program." (H.Rept. 109-89, p. 463) In Section 3111 of H.R. 1815, the committee required the Secretary of Energy, in consultation with the Secretary of Defense, to carry out the RRW program, and spelled out its objectives for RRW:

> (b) Objectives- The objectives of the Reliable Replacement Warhead program shall be —
>
> (1) to increase the reliability, safety, and security of the United States nuclear weapons stockpile;
>
> (2) to further reduce the likelihood of the resumption of nuclear testing;
>
> (3) to remain consistent with basic design parameters by using, to the extent practicable, components that are well understood or are certifiable without the need to resume underground nuclear testing;
>
> (4) to ensure that the United States develops a nuclear weapons infrastructure that can respond to unforeseen problems, to include the ability to produce replacement warheads that are safer to manufacture, more cost-effective to produce, and less costly to maintain than existing warheads;

> (5) to achieve reductions in the future size of the nuclear weapons stockpile based on increased reliability of the reliable replacement warheads;
>
> (6) to use the design, certification, and production expertise resident in the nuclear complex to develop reliable replacement components to fulfill current mission requirements of the existing stockpile; and
>
> (7) to serve as a complement to, and potentially a more cost-effective and reliable long-term replacement for, the current Stockpile Life Extension Programs.

The committee's report (pp. 464-465) described these objectives in more detail. Section 3111 of H.R. 1815 also required the Nuclear Weapons Council to submit an interim report on RRW by March 1, 2006, and a final report by March 1, 2007. The final report is to: assess characteristics of warheads to replace existing ones; discuss the relationship of RRW within SSP and its impact on LEPs; assess the extent to which RRW, if successful, could lead to a reduction in warhead numbers; discuss RRW design criteria that will minimize the likelihood of nuclear testing; describe the infrastructure needed to support RRW; and summarize how funds will be used.

Of the committee's 28 Democratic members, 23 signed a statement of additional views (H.Rept. 109-89, pp. 511-512). According to the statement, "Democrats are willing to explore the concept of the RRW program, but do not yet embrace it." They felt that, to merit support, RRW must reduce or eliminate the need for nuclear testing, lead to dramatic reductions in the arsenal, avoid introducing new mission or weapon requirements, deemphasize nuclear weapons' military utility, increase nuclear security, and "[lead] to ratification and entry into force of the Comprehensive Test Ban Treaty." On the latter point, they maintained that a successful RRW program should erase the main rationale against the treaty, uncertainty about the reliability of the nuclear arsenal. Therefore, "[w]e believe strongly that ratification of the CTBT [Comprehensive Test Ban Treaty] is the logical end result of a successful RRW program..."

The Senate Armed Services Committee reported the FY2006 National Defense Authorization Bill, S. 1042, on May 17.[63] It recommended providing the amount requested for RRW. It noted that NNSA Administrator Brooks had presented several goals for RRW in his testimony to the committee on April 4:

- increasing warhead security and reliability;
- developing replacement components that can be manufactured more easily, using materials that are more readily available and more environmentally benign;
- developing replacement components that provide high confidence in warhead safety and reliability;

[63] Material in this paragraph is from U.S. Congress, Senate Committee on Armed Services, *National Defense Authorization Act for Fiscal Year 2006*, report to accompany S. 1042, 109th Cong., 1st sess., S.Rept. 109-69, (Washington: GPO, 2005), p. 482.

- developing these components on a schedule that would reduce the need to conduct a nuclear test to address a reliability problem;

- reducing the cost and increasing the responsiveness of the infrastructure; and

- increasing confidence in the stockpile enough to permit reductions in non-deployed warheads.

"The committee supports these goals and this modest investment in feasibility studies." It required NNSA's Administrator to submit a report to the congressional defense committees by February 6, 2006, "describing the activities undertaken or planned for any RRW funding in fiscal years 2005, 2006, and 2007." The bill passed the Senate, 98-0, on November 15. The reporting requirement was superseded by a similar requirement in the conference bill.

The defense authorization conference bill, as reported (H.Rept. 109-360) December 8, included the House provision on RRW, somewhat revised, as Section 3111 of the conference bill. Conferees stated:

> The conferees support the goal of continuing to ensure that the nuclear weapons stockpile remains safe, secure, and reliable. The conferees believe that the Reliable Replacement Warhead program is essential to the achievement of this goal and support its establishment with the objectives as defined in the provision [section 3111], and as further described in the committee reports of the Committees on Armed Services of the Senate and the House of Representatives for fiscal year 2006.[64]

The measure was signed into law (P.L. 109-163) January 6, 2006.

The Senate Appropriations Committee reported H.R. 2419 on June 16.[65] It endorsed RRW and recommended increasing its funding above the FY2006 request.

> The Committee recognizes that RRW is early in its development and will not significantly alter the near-term plans for stockpile support such as LEPs, but NNSA is encouraged to move aggressively to incorporate benefits from RRW into the stockpile as soon as possible.
>
> The Committee recommends $25,351,000 for RRW to accelerate the planning, development and design for a comprehensive RRW strategy that improves the reliability, longevity and certifiability of existing weapons and their components.[66]

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[64] U.S. Congress. Committee of Conference, *National Defense Authorization Act*, conference report to accompany H.R. 1815, 109th Cong., 1st sess., H.Rept. 109-360, 2005, p. 900.

[65] U.S. Congress, Senate Committee on Armed Services. *Energy and Water Appropriations Bill, 2006,* S.Rept. 109-84, to accompany H.R. 2419. 109th Cong., 1st sess., 2005.

[66] Ibid., p. 155.

The bill passed the Senate, 92-3, on July 1, with no change to the RRW provision.

Conferees on the energy and water bill reported H.R. 2419 (H.Rept. 109-275) on November 7, 2005. The House agreed to the conference bill, 399-17, on November 9, and the Senate agreed to it, 84-4, on November 14. The President signed it into law (P.L. 109-103) November 19. The bill provides $25.0 million for RRW. Conferees wanted the Complex to use various resources "to support a Nuclear Weapons Council determination in November 2006."[67] This determination would be a decision on which design to use for the first reliable replacement warhead. Conferees also emphasized goals and requirements of the RRW program:

> The conferees reiterate the direction provided in fiscal year 2005 that any weapon design work done under the RRW program must stay within the military requirements of the existing deployed stockpile and any new weapon design must stay within the design parameters validated by past nuclear tests. The conferees expect the NNSA to build on the success of science-based stockpile stewardship to improve manufacturing practices, lower costs and increase performance margins, to support the Administration's decision to significantly reduce the size of the U.S. nuclear stockpile.[68]

In sum, Congress supported RRW in various ways in the FY2006 budget cycle. Both Armed Services Committees recommended fully funding the request, both Appropriations Committees recommended a sharp increase in RRW funding, and Congress appropriated $25.0 million, reduced to $24.75 million by a rescission.[69] The four committees saw RRW as a way to achieve a wide range of goals for the nuclear weapons program, spelled out many of these goals in legislation and in committee reports, and required several reports to track the status of RRW.

Congressional Action on the FY2007 RRW Request

NNSA's FY2007 budget document[70] evidenced a program that gained momentum in the preceding year. The request for RRW was $27.7 million, up from $24.8 million for FY2006. (p. 71) (Page numbers in parentheses in the next few paragraphs refer to NNSA's FY2007 budget document.) Outyear budgets are: FY2008, $14.6 million; FY2009, $29.7 million; FY2010, $29.6 million; and FY2011, $28.7 million. (p. 72) The FY2006 budget request document contained few references to RRW because the program received its first funding just two months

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[67] U.S. Congress. Committee of Conference, *Making Appropriations for Energy and Water Development for the Fiscal Year Ending September 30, 2006, and for Other Purposes*, H.Rept. 109-275, to accompany H.R. 2419. 109th Cong., 1st sess., 2005, pp. 158-159.

[68] Ibid., p. 159.

[69] "The FY 2006 [amount] includes an across-the-board rescission of 1 percent in accordance with the Department of Defense Appropriations Act, 2006, P.L. 109-148." U.S. Department of Energy, Office of Chief Financial Officer, *FY2007 Congressional Budget Request*, vol. 1, National Nuclear Security Administration, DOE/CF-002, February 2006, p. 71.

[70] Department of Energy, *FY2007 Congressional Budget Request*, vol. 1.

before that document was released. In contrast, the FY2007 document contains 30 or more references to RRW that show many sites and programs linked to RRW. Programs are discussed below; sites include Kansas City Plant (p. 620), Livermore (p. 627), Los Alamos (p. 635), Pantex (p. 646), Sandia (p. 651), and Y-12 (p. 665). What emerges is a program that is drawing on many resources of the Complex beyond the program's own budget. This is in accord with a directive in the FY2006 energy and water conference report:

> The conferees expect that the laboratories and plants will also utilize the existing resources in the Directed Stockpile, Campaigns, and Readiness in Technical Base and Facilities accounts [the three largest accounts of the Stockpile Stewardship program] where applicable to further the RRW design options to support a Nuclear Weapons Council determination in November 2006.[71]

Various programs expect to support RRW in many ways:

- "During the period FY 2007-2011, the Science Campaign will endeavor to make significant progress toward providing the experimental data and certification methodologies necessary to support the current stockpile workload and future requirements that will include the Reliable Replacement Warhead and reflect an evolving stockpile." (p. 96)

- Within the Dynamic Materials Properties program of the Science Campaign, "A second principal effort is to characterize the reaction kinetics and dynamics of high explosives, with special emphasis on improving the modeling of insensitive high explosives that will be used in replacement warheads to provide improved safety and surety." (p. 100)

- Within the Engineering Campaign, Enhanced Surveillance deliverables in the outyears are planned to support Reliable Replacement Warhead components assessment" (p. 116) and the Enhanced Surety program "will support studies such as the Reliable Replacement Warhead." (p. 118)

- "Only through ASC [the Advanced Simulation and Computing Campaign] simulations can National Nuclear Security Administration (NNSA) determine the effects of changes to current systems as well as margins and uncertainties in future and untested systems, such as the RRW." (p. 176)

- Within the Pit Manufacturing and Certification Campaign, "Additional personnel will be hired and additional equipment procured to support manufacture of existing pit types (or a RRW pit)," and Los Alamos and Livermore "will continue planning and

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[71] Committee of Conference, *Making Appropriations for Energy and Water Development for the Fiscal Year Ending September 30, 2006...*, H.Rept. 109-275, pp. 158-159.

> development of integral experiments in FY2007 in support of certification of reliable replacement warhead pits." (p. 191)

The budget document offers many details of the proposed program.

> The Nuclear Weapons Council (NWC) approved the Reliable Replacement Warhead (RRW) Feasibility Study which began in May 2005, and is expected to take 18 months to complete. The goal of the RRW Study is to identify designs that will sustain long term confidence in a safe, secure and reliable stockpile and enable transformation to a responsive nuclear weapon infrastructure. The Joint DOE/DOD RRW Project Officer's Group (POG) was tasked to oversee a laboratory design competition for a RRW warhead with the FPU [first production unit] goal of FY 2012. The POG will assess technical feasibility including certification without nuclear testing, design definition, manufacturing, and an initial cost assessment to determine whether the proposed candidates will meet the RRW study objectives and requirements. At the end of the study, the POG will establish the preferred RRW design options and recommendations to the NWC Standing and Safety Committee (NWCSSC) and NWC. ...
>
> In FY 2007 specific activities include: with NWC approval, proceed with detailed design and preliminary cost estimates of RRW concepts to confirm that RRW designs provide surety enhancements, can be certified without nuclear testing, are cost-effective, and will support both stockpile and infrastructure transformation. (83)

Further, "The RRW budget will increase when the RRW option is selected and starts development and production engineering activities." (76)

The John Warner National Defense Authorization Act for Fiscal Year 2007, P.L. 109-364 (H.R. 5122), increased the amount requested by $20.0 million to support a second RRW design competition. It required NNSA to submit a plan for transform the Complex to achieve a responsive infrastructure by 2030 (Section 3111), with a report on the plan due February 1, 2007. An objective of the plan is "To prepare to produce replacement warheads under the Reliable Replacement Warhead program at a rate necessary to meet future stockpile requirements, commencing with a first production unit in 2012 and achieving steady-state production using modern manufacturing processes by 2025." It required (Section 3116) NNSA to enter into an arrangement with the National Academy of Sciences to have the latter prepare a study of Quantification of Margins and Uncertainties, a method to assess the nuclear stockpile. The study is to evaluate, among other things, "Whether the application of the quantification of margins and uncertainty used for annual assessments and certification of the nuclear weapons stockpile can be applied to the planned Reliable Replacement Warhead program so as to carry out the objective of that program to reduce the likelihood of the resumption of underground testing of nuclear weapons." As of December 2006, the study is anticipated for January 2008.[72]

[72] Information provided by National Academy of Sciences, December 12, 2006.

The House Appropriations Committee "supports the RRW, but only if it is part of a larger package of more comprehensive weapons complex reforms."[73] It criticized NNSA's Complex 2030 plan as basically modernization in place, and favored a plan by a DOE task force.[74] It recommended $52.7 million for RRW, an increase of $25.0 million, but fenced the latter amount until DOE provides the committee with a "comprehensive complex transformation plan."[75] It directed NNSA to engage the JASON Defense Advisory Group to "evaluate the competing RRW designs" and to analyze "the feasibility of the fundamental premise of the RRW initiative that a new nuclear warhead can be designed and produced and certified for use and deployed as an operationally-deployed nuclear weapon without undergoing an underground nuclear test."[76] The report is due March 31, 2007. Professor Roy Schwitters, Chair of the JASON Steering Committee, met with House Appropriations Committee staff and NNSA officials to set a schedule for the JASON study; the schedule calls for a preliminary report to be submitted to NNSA by March 1, 2007, an executive summary of the final report by August 1, 2007, and the final report by October 1, 2007.[77] The House passed the bill, 404-20, on May 24, 2006, with no amendments to RRW provisions.

The Senate Appropriations Committee recommended $62.7 million for RRW.

> The Committee ... recognizes the need to protect against unforeseen challenges and urges the NNSA to accelerate the transition to a responsive infrastructure and to proceed expeditiously with the RRW design. The Committee also realizes that a dual track strategy of supporting eight legacy systems and a RRW program is not sustainable and therefore has taken steps in this legislation to reduce the number of legacy systems and begin the replacement with RRW designs. The Committee has also initiated a second design competition for another RRW design ...[78]

Regarding this second competition, the committee urged DOE and NNSA to "expand the RRW program immediately to ensure that our strategic forces have at least two different certified RRW warheads" to guard against a failure in one system. It recommended that $10.0 million be used for this second competition, with a first

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[73] U.S. Congress. House Committee on Appropriations. *Energy and Water Development Appropriations Bill, 2007,* H.Rept. 109-474 to accompany H.R. 5427, 109th Cong., 2nd sess., 2006, p. 108.

[74] Ibid., p. 107. For the task force plan, see U.S. Department of Energy. Secretary of Energy Advisory Board. Nuclear Weapons Complex Infrastructure Task Force. Recommendations for the Nuclear Weapons Complex of the Future, 2005.

[75] House Committee on Appropriations, *Energy and Water Development Appropriations Bill, 2007,* p. 108, 111.

[76] Ibid., p. 109-110.

[77] Information provided by Roy Schwitters, S.W. Richardson Foundation Regental Professor of Physics, University of Texas at Austin, and Chair of the JASON Steering Committee, email, January 29, 2007.

[78] U.S. Congress. Senate Committee on Appropriations. *Energy and Water Appropriations Bill, 2007,* S.Rept. 109-274 to accompany H.R. 5427, 109th Cong., 2nd sess., 2006, p. 146.

production unit goal of 2014.[79] It recommended adding $4.0 million to "accelerate the deployment" of surveillance devices into the RRW design.[80] This bill was placed on the Senate legislative calendar on June 29, but the Senate took no further action on it.

Congress did not pass a separate FY2007 Energy and Water Development Appropriations Act, but instead included these funds in a continuing resolution (P.L. 110-5, February 15, 2007) to fund energy and water and many other programs through the balance of FY2007. DOE's FY2007 operating plan includes $35.8 million for RRW.

Congressional Action on the FY2008 RRW Request

The President submitted his FY2008 budget request to Congress on February 5, 2007. The NNSA request document presents details of the DOD-NNSA plan for RRW. In November 2006,[81] according to the document,

> the NWC [Nuclear Weapons Council] decided that the RRW for submarine launched ballistic missiles is feasible and should proceed to complete a Phase 2A design definition and cost study. In addition, the NWC determined that the RRW is to be adopted as the strategy for maintaining a long term safe, secure and reliable nuclear deterrent and as such also directed the initiation of a conceptual study for an additional RRW design.[82]

The document also stated that the

> shift in strategy from a Life Extension Program to a RRW program will require substantial planning and resource realignments between the Departments of Defense and Energy that will not be completed in time for the FY 2008 budget submission. When planning is complete, expected at the end of FY 2007, an RRW budget adjustment will be requested.[83]

It further stated that the budget approach for FY2008 for transforming the nuclear stockpile included the following goal: "Maintain a relatively level DSW [Directed Stockpile Work] budget with RRW development funded through reductions in resources required to support legacy weapons."[84]

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[79] Ibid., p. 148.

[80] Ibid., p. 151.

[81] U.S. Department of Energy. Office of Chief Financial Officer. *FY 2008 Congressional Budget Request.* Volume 1, National Nuclear Security Administration. DOE/CF-014, February 2007, p. 19. Available at [http://www.mbe.doe.gov/budget/08budget/Content/Volumes/Vol_1_NNSA.pdf].

[82] Ibid., p. 88.

[83] Ibid., p. 19.

[84] Ibid., p. 64. Directed Stockpile Work, or DSW, is the part of the Weapons Activities

(continued...)

While NNSA's RRW budget figures are thus subject to revision, the projected figures as presented are as follows (in millions): FY2008, $88.769; FY2009, $99.787; FY2010, $109.240; FY2011, $167.358; and FY2012, $179.933.[85] In addition, the Navy requests $30.0 million for FY2008, and estimates a request of $50.0 million for FY2009, for RRW.[86] These figures are DOD funds to develop a cost estimate and to "[c]ontinue the RRW Program into Phase 3 Engineering Development, when approved by Congress and the Nuclear Weapons Council."[87] Examples of this work for RRW include development of an arming, fuzing, and firing system and of "ancillary reentry body types," as well as integration of RRW with the Trident II (D5) missile that will carry the RRW.[88] The Navy plans to award contracts for at least $29.5 million of the FY2008 request in October 2007, and for at least $49.0 million of the FY2009 request in October 2008.[89] While keeping in mind NNSA's caveats, the projected total for RRW in the NNSA budget for FY2008-FY2012 and the Navy budget for FY2008-FY2009 is $725.1 million.

The House Armed Services Committee's Strategic Forces Subcommittee mark of H.R. 1585, the FY2008 defense authorization bill, took several actions relating to RRW. It sought "to create a public discussion about future requirements for nuclear weapons by establishing a congressionally-appointed, bipartisan congressional commission to re-evaluate the U.S. strategic posture." It directed DOE and NNSA "to 'walk before they run' with modernization of the nuclear weapons stockpile and the nuclear weapons complex. Toward that end, the mark limited use of all RRW funds to Phase 2a design and cost study activities." (See the next section for a description of weapon phases.) It reduced NNSA's RRW request of $88.8 million by $20.0 million, and reduced the Navy's RRW request of $30.0 million by $25.0 million. It eliminated the entire $24.9 million request for the proposed Consolidated Plutonium Center. It reduced the B61 LEP, for which $63.1 million was requested, by $4.2 million "with direction to defer the start of any new LEP activity pending further evaluation of the RRW program." It also "[d]irects NNSA to assess the

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[84] (...continued)
budget that involves work directly on nuclear weapons in the stockpile, such as monitoring their condition; maintaining them through repairs, refurbishment, life extension, and modifications; R&D in support of specific warheads; and dismantlement. "Legacy weapons" are those currently in the stockpile, which were designed, tested, manufactured, and deployed during the Cold War; the Life Extension Program is one of the programs within the Stockpile Stewardship Program that is used to maintain them.

[85] Ibid., pp. 75, 76.

[86] U.S. Department of the Navy. *Fiscal Year (FY) 2008/2009 Budget Estimates: Justification of Estimates,* Research, Development, Test & Evaluation, Navy, Budget Activity 7, February 2007, at [http://www.finance.hq.navy.mil/fmb/08pres/rdten/RDTEN_ba7_book.pdf], pages (using pdf numbers) 24-25, 40-42.

[87] Ibid., pdf p. 41.

[88] Ibid.

[89] Ibid., pdf p. 42.

feasibility of reusing existing plutonium pits in the RRW program."[90] In marking up the bill on May 9, the House Armed Services Committee retained these provisions.

Policy Options and Issues for the 110th Congress

The RRW program has made considerable progress since its inception, opening new choices and questions for Congress.

Drop RRW. Congress could short-circuit the entire decision process that RRW would entail by terminating RRW and proceeding with LEP only. CRS Report RL33748 presents many arguments for and against this course of action.

Slow the pace of RRW. The first production unit of RRW is scheduled for 2012 or 2014, as noted earlier. At the same time, the pit aging study referenced above has extended the anticipated service life of pits considerably. Since one justification for proceeding quickly with RRW was the fear that age-related defects might cause pits not to function correctly by about the time a new pit manufacturing facility could become operational, the extended "lease on life" offered by the pit aging report might permit RRW to proceed at a slower pace. A press report stated,

> Some members of Congress have said the plutonium studies raised questions about the need for the RRW program. Rep. David L. Hobson ... said yesterday that, based on the plutonium studies, "they should take a breath because there are lots of demands for money." He added: "Congress is not going to be as robust about this though there is a need to have some scientific work done."[91]

Gather more information. The 110th Congress will not need to make a final decision to proceed with RRW. That decision will come due if NNSA requests funds to begin full-scale development, currently expected around FY2010. Further, many current unknowns could make a decision to proceed with RRW premature. Cost is important to the decision, yet long-term cost projections are notoriously unreliable. There are technical uncertainties, such as whether the winning RRW design can be turned into a functioning warhead. The future Complex has yet to be determined, along with how it might differ depending on whether the United States pursues LEP or RRW and how it would handle a transition to an all-RRW stockpile. Stockpile numbers decades out are unknowable, yet a Complex would spend money unnecessarily if sized too large and could not support requirements if sized too small. Unless it rejects RRW, Congress may wish to use the time before a decision must be made to gather more information to bound these unknowns.

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[90] U.S. Congress. House. Committee on Armed Services. "Strategic Forces Subcommittee Chairman Ellen Tauscher, Strategic Forces Subcommittee Markup of H.R. 1585, The National Defense Authorization Act for FY08," May 2, 2007, available at [http://armedservices.house.gov/apps/list/speech/armedsvc_dem/tauscheros050207.shtml].

[91] Walter Pincus, "New Nuclear Weapons Program to Continue," *Washington Post*, December 2, 2006, p. 7.

Examine the link between RRW and a reconfigured Complex. Some argue that the Complex must be streamlined and consolidated to support RRW, and that RRW will permit a smaller and less costly Complex because RRW components will be easier to manufacture and assemble and will use less hazardous material. On the other hand, revising the Complex would be very costly, as would production of perhaps thousands of RRWs, and the pit aging study may provide grounds for delaying a decision on Complex reconfiguration. Congress may wish to determine how long it would take for savings from RRW and a reconfigured Complex to exceed the investment costs, with both figures adjusted for net present value to reflect the time value of money.[92] Congress may also consider what upgrades the Complex would need in order to support LEPs.

Consider the scheduling of a second RRW design competition. A congressional report called for a second competition with an FPU of FY2014.[93] A second RRW, if designed so that it could back up the first, would guard against the prospect that the failure of one RRW type could force the withdrawal of part of the U.S. strategic nuclear force. A second RRW design competition would also help maintain the RRW program. On the other hand, a 2012 FPU for the first RRW appears optimistic, as noted, so a 2014 FPU for a second RRW may be as well. More time between a first and second RRW would give more opportunity for refining RRW design and for feedback from production to design. Further, alternate warheads for each type of long-range bomber and missile are available if the first RRW encountered a problem. At issue are whether to initiate a second RRW design competition and, if so, on what schedule.

Consider how to handle moving RRW-1 to a more advanced phase of development. Nuclear weapons development proceeds in carefully-defined "phases." This process dates back at least to a 1953 agreement between the Atomic Energy Commission (a predecessor agency of DOE) and DOD that numbers the phases as follows: 1, weapon conception; 2, program study; 3, development engineering; 4, production engineering; 5, first production; 6, quantity production and stockpile.[94] The Nuclear Weapons Council updated this agreement in 2000 with guidelines for a "Phase 6.X Process" in which the phases in the 1953 agreement were applied to refurbishment of existing weapons, i.e., those in Phase 6.[95] Thus, Phase 6.1 was concept assessment for refurbishing an existing weapon. The 2000 update

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[92] For further information on net present value, see U.S. Department of Defense. Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics. "Contract Pricing Reference Guides," at Defense Procurement and Acquisition Policy website, [http://www.acq.osd.mil/dpap/contractpricing/vol2chap9.htm].

[93] U.S. Congress. Senate. Committee on Appropriations. *Energy and Water Appropriations Bill, 2007*. S.Rept. 109-274, 109th Congress, 2nd Session, 2006, p. 148.

[94] U.S. Atomic Energy Commission. "An Agreement Between the AEC and the DOD for the Development, Production, and Standardization of Atomic Weapons," March 21, 1953, 10 p.

[95] U.S. Department of Defense and Department of Energy Nuclear Weapons Council. "Procedural Guideline for the Phase 6.X Process," April 19, 2000, 13 p.

included a Phase 6.2A, design definition and cost study. By extension, Phase 2A is design definition and cost study for a new warhead.

NNSA staff provided the following information in April 2007. The plan is for the first RRW to enter Phase 2A in early May 2007, with a goal of completing that phase by the end of December 2007. The weapon would then be ready for a decision by the Nuclear Weapons Council on moving to Phase 3. If the council approves, during FY2008, of beginning RRW Phase 3, NNSA might ask the Armed Services and Appropriations Committees for approval to reprogram funds for that purpose. Most of the $88.8 million requested for RRW for FY2008 is for work on Phase 2A, with a small portion of the money for Phase 3 work.

RRW's transition from Phase 2A to Phase 3 is an important issue for Congress for at least two reasons. Phase 3 involves considerably more money than does Phase 2A. In addition, while Phase 2A is a study, the results of which might lead to the cancellation of a weapon program, Phase 3 carries a much stronger presumption that the weapon will proceed through development to production and deployment. Legislation reflects the importance of the move from Phase 2A to Phase 3. P.L. 107-314, FY2003 National Defense Authorization Act, Section 3143, "Requirements for Specific Request for New or Modified Nuclear Weapons," requires that a request for funds for each new weapon in Phase 3 or higher, or for each modified weapon in Phase 6.3 or higher, with exceptions such as for life extension programs, be presented as a separate line item, while requests for funds for earlier phases are to be combined into a single line item. P.L. 108-136, FY2004 National Defense Authorization Act, Section 3117, also highlights the importance of engineering development as a congressional decision point by barring the Secretary of Energy from beginning engineering development or any subsequent phase of the Robust Nuclear Earth Penetrator without specific congressional authorization.

The move to Phase 3 raises several issues for Congress and NNSA.

- Is Congress aware of this move? In a hearing of March 2007, Senator Bill Nelson asked Acting NNSA Administrator Thomas D'Agostino "Now that [the Nuclear Weapons Council] has approved the feasibility study, will the '08 funding be used to finish the Phase 2A study and begin the Phase 3 study?" Mr. D'Agostino answered, "Yes."[96] On the other hand, NNSA's FY2008 budget did not request RRW funds specifically to move the first RRW from Phase 2A to Phase 3.[97] While NNSA presents RRW as a separate line item for FY2008, it made all earlier requests for RRW funds, i.e., those for FY2006 and FY2007, as a separate line item as well, so presentation

[96] U.S. Congress. Senate. Committee on Armed Services. Subcommittee on Strategic Forces. Hearing on the FY2008 strategic forces program budget, March 28, 2007.

[97] The FY2008 RRW request references completion of the Phase 2A study. U.S. Department of Energy. Office of Chief Financial Officer. *FY 2008 Congressional Budget Request.* Volume 1, National Nuclear Security Administration. DOE/CF-014, February 2007, p.88. Nowhere in the entire 637-page volume, however, is there a reference to "Phase 3."

as a separate line item would not by itself indicate that RRW was to move into Phase 3.

- In theory, NNSA could ask Congress to approve Phase 3 as part of the regular FY2008 National Defense Authorization Act and Energy and Water Development Appropriations Act. However, Phase 2A is not likely to finish before the end of December 2007, by which time those bills may well be completed. NNSA indicates that it would not request Phase 3 funds before the Nuclear Weapons Council had evaluated Phase 2A results and decided whether or not the first RRW merited moving to Phase 3.

- If the Nuclear Weapons Council recommends proceeding with Phase 3 in the first few months of 2008, NNSA might want to begin Phase 3 promptly in FY2008 by way of a reprogramming. Would that approach be acceptable to Members of Congress not on the relevant committees who might wish to have a direct voice in the decision?

- If NNSA chooses to present the Phase 3 decision as part of the FY2009 budget cycle and RRW does not begin Phase 3 until the FY2009 budget is approved, possibly the fall of 2008, what happens to the RRW program during the hiatus from December 2007 until the budget is approved? NNSA indicates that it would continue basic experiments and technology development for RRW as an extension of Phase 2 that could considerably reduce risks and future schedule, as funding allowed.

As noted in the preceding section, the House Armed Services Committee's Strategic Forces Subcommittee mark of the FY2008 defense authorization bill, H.R. 1585, "limits use of all RRW funds to Phase 2a design and cost study activities," and the full committee mark retained this provision.

Should RRW be linked to the Comprehensive Test Ban Treaty (CTBT)? The CTBT bars all nuclear explosions.[98] The United States and other nations signed it beginning in 1996; as of May 2007, 177 nations have signed it and 138 have ratified. However, 44 specified nations must ratify for it to enter into force, and ten, including the United States, have not ratified. The Senate rejected it in 1999 on such grounds as the capability of the Stockpile Stewardship Program to maintain current warheads, possible need for new warheads, need for new security features, questions about monitoring ability, and the prospect that other nations might make militarily significant gains through clandestine testing. With the passage of time, some argue that Stockpile Stewardship has demonstrated its capability, Congress has rejected new warheads for new missions, and detection capability has improved greatly. In this view, the CTBT merits a reconsideration. Others prefer to avoid nuclear testing but also do not want to enter the CTBT; they would maintain the current moratorium. Still others argue that Stockpile Stewardship tools have not

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[98] See U.S. Congress. Congressional Research Service. *Nuclear Weapons: Comprehensive Test Ban Treaty.* CRS Report RL33548, by Jonathan Medalia.

been verified by nuclear testing, militarily significant clandestine cheating is still possible, and some security features could be added only with testing. They would resume testing at a low pace and low yield.

RRW's support in Congress has by some accounts diminished,[99] so some favoring RRW see a CTBT-RRW link as a possible quid pro quo. Similarly, some favoring the CTBT also raise the prospect of a quid pro quo, arguing that NNSA claims that RRW will reduce the likelihood of a need to return to testing. On the other hand, some RRW supporters see RRW as deserving approval on its merits and fear that the CTBT could impair U.S. security, while some CTBT supporters feel that the prospects for CTBT ratification will increase over time and that RRW undermines U.S. ability to take the lead on nuclear nonproliferation; advocates of both positions would reject a CTBT-RRW link.

Will RRW weaken U.S. nuclear nonproliferation efforts? RRW advocates hold that LEP will cause confidence in the stockpile to decline, and with it U.S. ability to assure allies that the U.S. deterrent is sound, to dissuade competitors from beginning nuclear programs, to deter adversaries, and if necessary to defeat enemies, as called for in the 2001 Nuclear Posture Review. In contrast, they say, RRW is designed as a replacement weapon rather than a new weapon with new military capabilities, and one that will be easier to manufacture, maintain, and certify than current warheads, with wider performance margins to raise confidence that it will work as intended. This confidence is important for nuclear nonproliferation because it makes friends and allies less inclined to develop their own nuclear weapons in response to actions of potential proliferators like North Korea or Iran. As Japanese Foreign Minister Taro Aso said shortly after the North Korean nuclear test of October 2006, "There is no need to arm ourselves with nuclear weapons either. For Japan's own defense we have this Mutual Defense Treaty with [the] United States and we have the commitment, and that commitment has been reconfirmed by Secretary Rice, that there is this commitment to make sure that the security system will work."[100] Without confidence in U.S. nuclear weapons, it is argued, that commitment becomes of questionable value. Moreover, any nation seeking to manufacture nuclear weapons would require a decades-long effort that is insensitive to U.S. actions. According to John Harvey, Director of NNSA's Policy Planning Staff, "The RRW effort itself has positive implications for non-proliferation. Because these warheads would be designed with more favorable performance margins, and be less sensitive to incremental aging effects, they would reduce the possibility that the United States would ever be faced with a need to conduct a nuclear test to diagnose or remedy a stockpile reliability problem." Further, he notes that this nation has taken many actions consistent with Article VI of the Nuclear Nonproliferation Treaty (NPT), in which the parties "[undertake] to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament." Such actions include

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[99] Walter Pincus, "Congress Skeptical of Warhead Plan," *Washington Post*, April 22, 2007, p. 5.

[100] U.S. Department of State. "Remarks [by Secretary of State Condoleezza Rice] with Japanese Foreign Minister Taro Aso After Their Meeting," Tokyo, Japan, October 18, 2006, available at [http://www.state.gov/secretary/rm/2006/74669.htm].

agreeing, in the Moscow Treaty, to significant reductions in operationally-deployed strategic nuclear weapons; taking steps to reduce the U.S. nuclear stockpile; and removing up to 200 metric tons of highly enriched uranium from weapons use.[101]

Critics are concerned that other nations would perceive RRW as a new weapon that is at odds with the reciprocity of obligations between nuclear and nonnuclear weapon states that is the core of the NPT, and particularly with U.S. obligations under Article VI. As a result, in this view, RRW would make it harder to deal with Iranian and North Korean nuclear programs, and those programs in turn could lead to a follow-on wave of possible proliferators. For example, if Japan, Saudi Arabia, and Egypt saw nuclear weapons spreading, they might undertake nuclear programs of their own. By signaling that the United States places heavy value on nuclear weapons through the RRW program instead of seeking to downplay and devalue these weapons, these critics maintain, the United States undermines its ability to lead worldwide nuclear nonproliferation efforts. Former Senator Sam Nunn said,

> On the RRW itself, if Congress gives a green light to this program in our current world environment -- and I stress in our current world environment -- I believe that this will be misunderstood by our allies, exploited by our adversaries, complicate our work to prevent the spread and use of nuclear weapons, ... and make resolution of the Iran and North Korea challenges all the more difficult. Also, I think it will make it more difficult to discourage the many new countries that are right on the tipping point of beginning their enrichment process. ... we will pay a very high price in terms of our overall national security if Congress goes forward with this program. ... So I would not fund additional work on the RRW at this time, certainly not development and going forward with deployment.[102]

Similarly, former Secretary of Defense William Perry said, "on balance, I believe that we could defer action for many years on the RRW program. And I have no doubt that this would put us in a stronger position to lead the international community in the continuing battle against nuclear proliferation, which threatens us all."[103]

Chronology, 2007-

01/00/08 — Completion is anticipated for a National Academy of Sciences study on Quantification of Margins and Uncertainties, a method to assess the nuclear stockpile. Among other things, the study will evaluate if this method can be applied to RRW. The study is required by P.L.

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[101] John Harvey, "U.S. Nuclear Weapons Programs: Implications for Nonproliferation," Remarks at NATO Conference: "NATO and the Future of the NPT," NATO Defense College, Rome, Italy, September 12, 2006 (as revised November 27, 2006), pp. 3, 6.

[102] U.S. Congress. House. Committee on Appropriations. Subcommittee on Energy and Water Development. Hearing on nuclear weapon activities. 109th Congress, 1st Session, March 29, 2007.

[103] Ibid.

109-364, the FY2007 National Defense Authorization Act, Section 3116.

12/31/07 — The Nuclear Weapons Council directed on March 13, 2007, that the RRW Phase 2A design definition and cost study be completed by this date.

10/01/07 — A final JASON report on RRW is scheduled to be completed. The report is required by the House Appropriations Committee's report on FY2007 energy and water appropriations.

08/01/07 — An executive summary of the JASON RRW report (see 10/01/07) is scheduled to be completed.

04/24/07 — The American Association for the Advancement of Science released a report, "The United States Nuclear Weapons Program: The Role of the Reliable Replacement Warhead."

03/02/07 — NNSA announced that the Nuclear Weapons Council selected the design by Livermore and Sandia-California as the winner of the RRW design competition.

03/01/07 — A preliminary JASON report on RRW (see 10/01/07) was scheduled to be completed.

03/01/07 — The Secretary of Energy and Secretary of Defense are to submit a final report to congressional defense committees on feasibility and implementation of the RRW program, as required by P.L. 109-163, FY2006 National Defense Authorization Act, Section 3111.

02/18/07 — A committee of the American Association for the Advancement of Science delivered an interim progress report, "The United States Nuclear Weapons Program: The Role of the Reliable Replacement Warhead."

02/05/07 — The President's FY2008 budget request was presented to Congress.

01/31/07 — NNSA released its "Report on the Plan for Transformation of the National Nuclear Security Administration Nuclear Weapons Complex," as required by P.L. 109-364, the FY2007 National Defense Authorization Act, Section 3111. An objective of the plan is "To prepare to produce replacement warheads under the Reliable Replacement Warhead program ..."

Appendix. Nuclear Weapons, Nuclear Weapons Complex, and Stockpile Stewardship Program

This report refers to nuclear weapons design, operation, and production throughout. This Appendix describes key terms, concepts, and facilities as an aid to readers not familiar with them.

Current strategic (long-range) and most tactical nuclear weapons are of a two-stage design.[104] The first stage, the "primary," is an atomic bomb similar in principle to the bomb dropped on Nagasaki. The primary provides the energy needed to trigger the second stage, or "secondary."

The primary has at its center a "pit," a hollow core containing fissile material (typically plutonium) and containment shells of other metals. It is surrounded by chemical explosive shaped to generate a symmetrical inward-moving (implosion) shock front. When the explosive is detonated, the implosion compresses the plutonium, increasing its density so much that it becomes supercritical and can sustain a runaway nuclear chain reaction. A neutron generator injects neutrons into the plutonium. The neutrons drive this reaction by splitting (fissioning) plutonium atoms, repeatedly doubling the number of neutrons released. But the chain reaction can last only the briefest moment before the force of the nuclear explosion drives the plutonium outward so that it becomes subcritical and can no longer support a chain reaction. To increase the fraction of plutonium that is fissioned, boosting the yield of the primary, another system injects "boost gas" — a mixture of deuterium and tritium (isotopes of hydrogen) gases — into the pit before the explosive is detonated. The intense heat and pressure of the fission chain reaction cause this gas to undergo fusion. While the fusion reaction generates energy, its purpose is to generate a great many neutrons and thus "boost" the fission chain reaction to a higher level.

A metal "radiation case" channels the energy of the primary to the secondary, which contains fission and fusion fuel. The energy ignites the secondary, which releases most of the energy of a nuclear explosion. The primary, radiation case, and secondary comprise the "nuclear explosive package." Thousands of "nonnuclear" components are also needed to make the nuclear explosive package into a militarily usable weapon, such as an arming, firing, and fuzing system, an outer case, and electrical and physical connections linking a bomb to an airplane or a warhead to a missile.

Nuclear weapons were designed, tested, and manufactured by the nuclear weapons complex, which is composed of eight government-owned contractor-operated sites: the Los Alamos National Laboratory (NM) and Lawrence Livermore National Laboratory (CA), which design nuclear explosive packages; Sandia National Laboratories (NM and CA), which designs nonnuclear components; Y-12 Plant (TN), which produces uranium components and secondaries; Kansas City Plant (MO),

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[104] U.S. Department of Energy, *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management,* DOE/EIS-0236, September 1996, summary volume, p. S-4. That page contains further information on nuclear weapon design and operation.

which produces many of the nonnuclear components; Savannah River Site (SC), which processes tritium from stockpiled weapons to remove decay products; Pantex Plant (TX), which assembles and disassembles nuclear weapons; and the Nevada Test Site, which used to conduct nuclear tests but now conducts other weapons-related experiments that do not produce a nuclear yield. These sites are now involved in disassembly, inspection, and refurbishment of existing nuclear weapons. The National Nuclear Security Administration (NNSA), a semiautonomous part of the Department of Energy, manages the nuclear weapons complex and program.

NNSA maintains nuclear weapons and associated expertise through the Stockpile Stewardship Program (SSP), which Congress created in the FY1994 National Defense Authorization Act (P.L. 103-160, section 3138). The legislation specified that the goal of SSP is "to ensure the preservation of the core intellectual and technical competencies of the United States in nuclear weapons" through "advanced computational capabilities," "above-ground experiments" (experiments not requiring nuclear testing), and construction of large experimental facilities. SSP has three main elements. Directed Stockpile Work involves work directly on nuclear weapons in the stockpile, such as monitoring their condition, maintaining them through refurbishment and modifications, R&D in support of specific warheads, and dismantlement. It includes the Life Extension Program and the RRW program. Campaigns provide focused scientific and engineering expertise in support of Directed Stockpile Work, in such areas as pit manufacturing and certification, computation, and study of the properties of materials. Readiness in Technical Base and Facilities funds infrastructure and operations at the nuclear weapons complex sites. While the legislation did not specify that SSP was not to involve nuclear testing, that goal seems clear from the history, and has become a goal of the program. NNSA does not rule out the possible need for testing, such as if a problem were to emerge in a warhead type that could not be remedied in any other way, but the United States has been able to maintain its nuclear stockpile without testing since 1992.